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GEOPHYSICAL MODELS FOR PARAPSYCHOLOGICAL EXPERIENCES†

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The statement is made that a basic problem in parapsychology is the presumed transmission of information from point or person A to point or person B without use of known sensory modes and stimulus sources. It is assumed the energy required for those paranormal cases which do not primarily involve peculiarities in brain chemistry or reinforcement history, does not originate from within the organism but within the environment in which the organism is exposed. Criteria are given for selection of geophysical or meteorological phenomena that may be candidate mechanisms for mediation of paranormal information. Detailed discussions are given about three naturally occurring candidates: extremely low frequency (biofrequency) electro-magnetic field waves, infrasonic waves and high voltage static electric fields from seismic-strain related sources. Information is given on the physical parameters, bio-behavioural effectiveness, possible contribution to paranormal experiences, and limitations of each candidate mechanism.

The essential problem for parapsychologists is conceptually a simple one: how does information get from point A to point B without using conventional sense modes and stimulus sources? Variations of this question can be also framed: how can information "inside" one person influence the behaviour of another over great distances? Similarly, how can a person "detect" the information of events that do occur sometimes later? By what mechanism does one see an ostensible spontaneous PK event?

From some points of view, the problem of information transfer is not a relevant issue. For a behaviourist, a putative telepathic event can be regarded as a further extension of the stimulus and response model. Operationally, one organism or event is the stimulus while another organism is the locus of the response. As long as the response can be measured, counted, and shown to be in some systematic relationship to the stimulus, isolation of the physical mechanism concerned is not required. The response may even be a verbal statement such as "I saw an apparition of my father," which is emitted during or just after the father's death (stimulus). There are many merits to this approach. For example, such an orientation would allow a person to study the object-avoidance behaviour of the bats without first knowing the existence of ultrasound. Contrary to many laymen's conceptions there is little difference in the essential operation between normal and paranormal stimulus-response situations. The critical issue for a strict behaviourist is to replicably demonstrate a relationship between some putative paranormal event designated as the stimulus and a consequent event designated as the response.

Other theorists prefer to approach instead the problem of information communication, usually by some attempts at elucidating the physical mechanism. Frequently suggestions are made that the energetic source of paranormal phenomena originates within the organism and that something *leaves* one organism (the putative agent) and influences a second organism (the putative percipient). From what we know presently about energy functions, these ideas are unrealistic. It is highly unlikely that sufficient amounts of stimulus energy could originate and be generated from the body-brain to any significant effectual distances. Physically speaking, the amounts of energy within the brain body are much too minute. Most of the energy that is emitted from the brain-body occurs in the infrared bands as a consequence of glycolysis. The alternative probable sources of bioenergies, the neurons, demonstrate the usual

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attenuation effects with distances. Since the spatial dimensions of neurogenic energies are within the millimicrometer ranges, attenuation factors exert their influences to within these orders of magnitude.

There is a second option: *Paranormal phenomena utilize the energy already available in the physical environment.* In other words, the energy required for a paranormal event to take place does not originate within the organism but within the environment in which the organism is exposed. Such an option is palatable within the context of known limits in biological energy expenditures as well as within the realm of normal occurrence. The human organism, like other life forms, is acutely sensitive to precise ranges of the various environmental forms of mechanical, gravitational, electromagnetic, and chemical stimuli. For example, we communicate visually because the eye sensors are sensitive to a small increment of the electromagnetic spectrum. However, the human organism does not transmit these energies, rather it modifies the energies that are already present. Objects are seen because they block the light in a particular manner and pattern. Information of a more paranormal nature may use this fundamental principle.

This paper deals primarily with the normal *geophysical and meteorological* changes that could exist as energy sources for paranormal experiences. Primary emphasis will be placed on the spontaneous cases. Suggestions will be made that normal physical environmental forces may be mediating the information from point A to point B or contributing to the effect. The mechanisms by which the available environmental energies are modulated by point A (*e.g.*, the agent), so that point B (*e.g.*, the percipient) can discriminate the signal is the topic of another paper. It is assumed that response to paranormal stimuli will depend upon the reinforcement history of the percipient in relation to the agent, the percipient's psychophysiological activity at the time of the stimulus presentation, and the components of the stimulus pattern. These principles have been discussed by the author elsewhere (Persinger, 1974a).

Paranormal experiences and events will be considered as reported phenomena that seem to involve operations in the organism and its environment not known to date, and do not seem to involve the processes which are predictable from the known laws of nature. It is realized that a vast number of cases due to a multitude of different etiologies are often singularly classified as paranormal or parapsychological events. Before attempts are made to invoke elaborate explanations, factors such as accidental reinforcement, superstitious conditioning, grief-induced changes in brain chemistry, and a variety of other situations that drastically affect "private experiences" must be considered. Such an effort is admittedly difficult in light of the predominant patterns for parapsychological events to directly or indirectly involve death, crisis and aversive stimuli. The pervasiveness of these stimuli on human behaviour is yet to be quantified. Ultimately the psychophysiological correlates of paranormal experiences will be isolated, and it appears from the trends in the history of science that such experiences will entail some modification of conditioning and learning principles now realized. With those relevant cases the problem will still remain: how can information get from point A to point B and what energies are involved?

BASIC ASSUMPTIONS

Often the role of the obvious is the most difficult to differentiate. The natural physical environment is replete with energy conditions which form a variety of frequencies, intensities, and configurations. Perhaps because they are so common or so global, they are ignored. Yet natural geophysical and meteorological energy sources are immense. Consider the massive stresses along fault lines that are exerted over an entire crustal block. Consider the mammoth voltages which are known to reach into the tens of thousands of volts per meter between the capacitor-like plates of the clouds and the earth's surface. Still other important but less known environmental sources exhibit geometries that allow the propagation of field-waves for millions of meters without appreciable attenuation.

Many of the natural forces of our everyday physical environment may contribute to an experience that would be labeled as a "psychical event." A first step is to determine some criteria that allow selection of those phenomena which best qualify as candidates for a physical mechanism that allows information to move from point A to point B. The characteristics of the problem dictate the prerequisites of the physical mechanism. For a physical environmental stim-

ulus to be selected as a candidate mechanism for a causal or correlational source of paranormal phenomena, the following criteria are required or implied.

1) *Natural occurrence.* This is a primary feature; the candidate mechanism must be known to occur in nature and be measurable.

2) *Penetrability.* The majority of paranormal experiences take place inside dwellings, consequently the candidate must have the physical capacity to penetrate walls.

3) *Low attenuation.* In some paranormal experiences, large distances separate the agent and percipient. The candidate must have significant propagational intensities with minimal attenuation.

4) *Bio-brain frequencies or intensities.* Paranormal experiences are often associated with specific electrical correlates of the brain, *e.g.*, alpha rhythms. A physical stimulus which is resonant or similar in frequency with those optimal paranormal-related brain frequencies should facilitate communication. Similarly, intensities which are sufficient to influence the d.c. potential system of the brain-body, upon which the time-varying fields (EEG) are superimposed, would also be of contributary importance.

5) *Known biological-behavioural effects.* Artificial simulation of the candidate in the laboratory should produce some measurable biological-behavioural effects. The effects should involve primarily the same general features mentioned in paranormal reports, with major influences upon the autonomic nervous system and correlated verbal behaviour. Exact reproduction of paranormal experiences would not be expected since the artificial signal would not be composed of the stimulus configurations that typify natural occurrences.

6) *Synchronous candidate-paranormal behaviour variations.* If the physical candidate is correlated with occurrence of paranormal events or experiences, then measurable fluctuations of one should be reflected in the other. Consequently, similarities in daily variations, seasonal highs and lows and other spatial-temporal properties should be found.

7) *Testable hypotheses.* Assumption that the physical candidate is highly correlated with the occurrence of paranormal phenomena should allow predictions to be made about paranormal occurrences by knowing the properties of the mechanism candidate a priori.

Three candidate mechanisms which occur in nature are: extremely low frequency electromagnetic fields, extremely low frequency sound (infrasound), and high voltage static electric fields. Each of these candidates will be discussed in terms of their normal occurrence parameters, their known experimental effects, and known or suspected correlations with reports of paranormal experiences.

EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS

Recent interest in psychophysiology and physics has been drawn towards the characteristics and effects of extremely low frequency (ELF) electromagnetic (EM) fields. ELF-EM field waves occur in nature and show high penetrability, low attenuation and wave pattern configurational differences. For discussion it can be assumed that the ELF band includes frequencies between 0.1 Hz and 100 Hz, well within the major power output ranges of the brain-body. A short summary of ELF physical properties and psychophysiological effects follows. More precise information is given in a review article by Persinger, Ludwig and Ossenkopp (1973) and in a recent text (Persinger, 1974b).

Physical Characteristics and Sources

ELF fields may occur in nature as waves or as ELF pulses from VLF or LF carrier waves. In the latter case, VLF waves, *e.g.*, 10 kHz, are received as short impulses lasting 10^{-1} to 10^{-4} seconds, the number of pulses per second being within the ELF range. Their intensities are frequency and source dependent. Magnetic components of the wave can range from less than 10^{-8} gauss to 10^{-2} gauss, while the electrical component can range from less than 2 mV/m to 1 V/m. Current densities around 10^{-5} amps/m have been reported. ELF field-waves are associated with weather changes, frontal movements, solar disturbances and thunderstorm activity. Some waves with spectral maxima near 1.5 Hz have been speculated to occur during seismic stresses in areas of appropriate quartz lattice structure. ELF signals that are attributed to weather instabilities propagate only a few hun-

dred kms. before attenuation, with the lower frequencies showing maximum propagation distance. Shifting of power spectra towards higher frequencies as such ELF sources approach also occurs.

At lower ends of the ELF bands, where the wavelengths begin to approximate the circumference of the earth, a unique resonance system between the ionosphere and earth is produced called the Schumann resonance. Power spectra of the Schumann resonance show maxima at about 7.8 Hz with harmonics at 14.1, 20.3 and 26.4 Hz. Exact propagational parameters depend on the boundary characteristics of the ionosphere. The principle amount of ELF energy remains within the spherical waveguide between the earth and ionosphere, consequently ELF waves in this mode can travel around the earth without appreciable attenuation. Damping values exist such that a 1 mV/m wave can traverse one million meters with only 10 percent loss of potential.

Wave patterns show interesting variations. ELF signals from VLF carriers may display oscillating sine-wave like patterns with exponential drops in peak amplitudes within pulse trains. ELF waves associated with weather conditions show patterns which are strikingly similar to the alpha and delta rhythm patterns of the human brain. König (1974; 1962) has repeatedly emphasized the interesting pattern similarities between the alpha frequencies in the human brain and ELF signals associated with clear days and high pressure areas. Delta rhythm frequencies are comparable to ELF signals associated with deep lying clouds and low pressure areas.

The intensity and number of ELF waves and impulses show diurnal variations, seasonal fluctuation, propagation direction differences and influences from local conductive sources. Amplitude peaks occur between 14:00 to 16:00 hr (LT) although relative peaks have also been observed between 02:00 to 04:00 hr (LT). Impulse numbers rapidly increase during May and June with peaks during August. West–east signal directions exhibit different propagational values than east–west directions as do north–south vs. south–north directions. Penetration of usual building materials is significant. ELF pulse carriers at 10 kHz demonstrate 95 percent transparencies through brick houses at 100 mV/m. Interestingly the exact amount of attenuation is heavily dependent upon the local magnetic field dip angle and time of day. Local water level, mineral content, topography and altitude show varying amplitude contributions. Gains as high as 60 db (*e.g.*, 1 mV to 1 V) between water poor valleys and higher plains with underground water sources have been reported. Similar changes have been noted as little as 100 m apart and in localized areas (Persinger, Ludwig and Ossenkopp, 1973). The possible relationship between these factors and areas that are reported cross culturally as "mana", "haunts", "unusual feelings", etc. demand investigation but are not within the context of this paper.

Behavioural-Biological Effects

ELF signals demonstrate penetrability, low attenuation, and ranges with power peaks at waveforms similar to those of the human brain. Behavioural-biological effects of these fields have also been reported (*e.g.*, see Persinger, *et al.*, 1973). Changes in reaction time, autonomic stabilities, emotional behaviours and deviations in oxygen uptake have been noted in both human and non-human subjects. Human subjects exposed to certain ELF field patterns report sensations of uneasiness, depression and "foreboding feelings". Other experimenters using radiofrequencies with pulse frequencies in the ELF range have published similar reports. Frey (1962) and Constant (1967) have noted that subjects "hear" radio waves of low pulse frequencies as "buzzings" or experience "pins-and-needles" and dizziness. The type of experience to the same stimuli shows marked individual variation.

Mechanisms by which low energies from natural ELF field waves could influence human behaviour is not clear. Several mechanisms have been proposed at various levels of discourse ranging from conformational changes in biogenic liquid crystals to resonance interactions with neuronal-glial systems. It has been argued (Persinger, 1974c) that natural electromagnetic signals may contain the appropriate "frequency-intensity-configurational key" to unlock organismic reactions. That life forms may show some type of frequency and intensity specificity has been suggested by the experiments of Brown (*e.g.*, 1966), Rocard (1964), and Becker (1972). Brown has shown that snails respond maximally to magnetic field intensities that approach natural values. Higher than normal values were less effective. Becker has indicated that tissue are discriminately responsive to extremely low current densities of

a few millimicroamps; intensities lower or higher are ineffective or destructive. Rocard found that human "dowser" subjects could detect experimentally manipulated magnetic fields with very weak gradients (0.001 gauss/meter). Such intensities are available in nature.

Relationships Between ELF-EM Fields and Paranormal Experiences

In a recently completed analysis project (Persinger, 1974d) spatial and temporal characteristics of ostensible paranormal experiences as measured by verbal behaviour of the reporter were recorded. Putative telepathic-clairvoyant and apparitional phenomena were shown to share a number of patterns. Marked increases of such experiences were reported to occur between 20:00 hrs and 08:00 hrs (local time) with a major peak between 02:00 and 04:00 hrs. ELF pulses from VLF carriers show marked similarity in this distribution, with some frequencies exhibiting major occurrence periods between 23:00 hrs and 07:00 hrs local time. During the summer months a secondary peak occurs between 02:00 and 04:00 hrs for the alpha-like frequencies of 8 Hz.

Like T-C and apparition reports, seasonal distributions of ELF pulses are predominately a summer phenomena. More precisely, a 6-month cycle is apparent with peaks during January and June and troughs during March and October. If indeed some wave phenomenon was associated with paranormal reports, such variation should be reflected. Global magnetic field storminess is one easily measured geophysical value and is intricately involved with ELF propagation since vertical and horizontal components of the magnetic field which act as wave guides for ELF signals are disturbed. Increased storminess would interfere with ELF propagation and presumably decrease T-C reports. Analysis for the data to date indicate a negative correlation of -0.58 between monthly magnetic storminess over the years (58 years averaged) and monthly T-C reports.

A number of other predictions can be made by knowing the characteristics of the candidate mechanism. Theoretically, a north-south direction of the agent-percipient should have the maximum probability of success. Perpendicular orientations would show less successful occurrences, although west–east agent-percipient orientations would be more effective than east–west directions. One would expect the geographical distribution of paranormal reports to reflect variations in relative dip angle values and topographic architectures which influence field propogation. Another postulate is that people who have: (1) predominate alpha frequencies which approximate local Schumann frequency values, and (2) more variability in the alpha ranges, would be the most likely agents and percipients. The latter property of frequency variability in brain electrical events of the agent or percipient increases probabilistic detection of ambient signals. Evidence exists that some physiological systems can be driven by ELF magnetic or electrical fields (Persinger, 1973; Wever, 1973).

Again the exact mechanisms by which environmental bio-frequencies could influence the organism are not clear. However behavioural-biological effects involving systems that seem involved with paranormal experiences have been verified. Energy exchange can take place if a system resonates with the frequencies of the applied field (Ludwig, Persinger and Ossenkopp, 1973). If this process can be demonstrated experimentally in life-forms, then interesting options for interpretation of ostensible psychokinetic phenomena are available. For example, do transient frequencies of the brain and heart electromagnetic systems in Soviet mediums during psychokinetic manifestations reflect a resonance between the medium's physical-electrical structure and energies from the environment? Does the peak frequency of the medium's brain overlap with the frequency and power spectra of local Schumann values or other biofrequency environment sources? Do either relaxation and corresponding changes in dominant EEG patterns or accidental modifications of muscular vibrations allow positive feedback sequences to initiate a series of waxing oscillations driven by the environmental stimulus? Is the high amplitude 8 Hz frequency band from the brains of human foci for Recurring Spontaneous Psychokinesis (RSPK) cases (e.g., Palmer, 1974) a symptom of resonance? Such questions can be answered with measurement and when they are perhaps a more adequate understanding of the mechanism can be obtained. The physical environment is an immense energy source; it is possible that some individuals may be able to tap from this reservoir.

Limitations of the Candidate

Despite the interesting possibilities of ELF-EM

phenomena as transmitters of psi-information, there are still complex conceptual problems. Parapsychology researchers are familiar with these difficulties. Enthusiastic mono-explanatory mechanisms have been proposed before, but it is unlikely that the existence of a singular mechanism could be responsible for all the phenomena we now classify under the label of "paranormal". No doubt as technology becomes more sophisticated and our measurement more accurate, the unknown and unusual will be slowly sliced away from the realm of the parapsychological.

ELF-EM fields may meet the criteria for a transmitter candidate, but there are still conceptual difficulties regarding the means by which psychophysiological changes of the agent during the psi-precipitating event (as in "telepathy") can influence the ambient ELF-EM field-waves and consequently affect the percipient. A type of modulation must be expected. ELF-EM waves passing through or near the agent must be changed in some manner that is familiar to the percipient. Again, the importance of shared conditioning histories between the agent and the percipient would be a fundamental prerequisite so that the percipient has been previously exposed to ELF-EM mediated changes from the agent.

Discrimination by the percipient of the agent's signal would involve a complex series of interactions. The accuracy or probability of detection of the agent's signal would certainly depend upon how closely the percipient's electrical changes are commensurate with the ambient signal. Conditions of dreaming, relaxation, or situations (*e.g.*, staring into space while washing dishes) that facilitate alpha or theta rhythm dominance during the appearance of the agent's signal in the immediate environment, would be essential. Since the patterns which allow any response at all to the agent's stimuli were conditioned before the incident, one would expect that any image or "thought response" associated with the stimulus to include images of the time of conditioning. Moreover, since only a finite number of discriminable stimulus patterns can exist in an extremely large population, occasional paranormal situations may involve percipients responding to agents who were not a part of the immediate family but do share (due to chance) similarities in stimulus pattern. Explanations and mechanisms of how this might take place and the consequences expected have been given elsewhere (Persinger, 1974a).

Another conceptual problem of paranormal stimulus detection is how the information could filter effectively into the immediate area of the percipient. Such dynamics require the limited number of ELF signals modulated by the small spatial area of the agent's body and periphery to concentrate near the percipient. A mechanism for focusing of signal waves into the percipient's geographical area would be mandatory. For psi-communication to occur in this manner either (1) precise alignment between agent and percipient (along the same ELF magnetic field guidelines) or (2) a large area that focuses ELF waves in the agent's immediate vicinity, would be required.

INFRASONIC STIMULI

The corresponding ELF phenomena which are a segment of the mechanical vibration spectrum have been termed infrasound. Until 1960 very little was known about this possible candidate.

Physical Characteristics

Infrasound includes by definition those sonic vibrations below the normal audible threshold. Typical periods of natural infrasound range from 4 to 20 seconds (0.25 Hz to 0.05 Hz) while some waves reach near audible levels (0.1 second or 10 Hz). Precise frequency bands often reflect source types. Intensities of infrasound waves seldom exceed 50 dynes/cm^2 (Cook and Young, 1962), and consequently their measurement can be masked by irregularly fluctuating winds that can attain values of 500 dynes/cm^2 at 15 to 25 mph. Exceptions do exist, and when Krakatoa exploded in 1883, infrasound traveled around the world several times (Cook, 1962). Infrasound has the same propagation speed as audible sound, about 344 m/sec at 20 degrees C., yet has marked penetrability for objects in its path.

Infrasound propagation has been associated with distant tornadoes, volcanoes, earthquakes and magnetic storms. Because of their low frequency, infrasonic waves in air can travel hundreds of kms with little attenuation. Infrasound associated with magnetic storms on the earth show interesting directional preferences from the north-east during the evening, north about midnight and northwest by early morning. Cook and Young (1962) have proposed the existence of a diffuse ELF sound source fixed in geomagnetic

coordinates on the side of the earth opposite the sun. This would mean that about one quarter of the globe is simultaneously bathed in acoustic pressures of about 1 dyne/cm^2.

Behavioural-biological Effects

Behavioural effects at intensities approximating orders of magnitude to nature sources have not been clearly demonstrated, although eels may use micro-seismic range signals as migration cues. At higher amplitude frequencies between 5 Hz and 10 Hz subjects report sensations described as body motions while others experience visual effects. Lower frequencies can induce feelings of apprehension, nausea or dizziness (Stephens, 1969). Infrasound has been implicated in human experiences of depression and fatigue as well as headaches (Gavreau, 1968). Gavreau (1968) noted that ordinary man-made sources (*e.g.*, defective air conditioners, fans) may produce similar effects, especially when the power output approached 1 watt. These sources could mask or accentuate effects produced by natural infrasound stimuli. Significant correlations between natural infrasonic levels and traffic accident rates and school absenteeism have been reported by Green and Dunn (1968).

Possible Contribution to Paranormal Experiences

Because of the instrumentation difficulties of infrasound detection, little public data has been available for comparison with reports of paranormal experiences. Infrasound, however, is an excellent candidate for at least some types of experiences, specifically those which involve the avoidance or detection of tornadoes, earthquakes, earth movements and other geophysical energies that involve low frequency mechanical vibration. One persistent tale that occurs in the popular literature is the peculiar behaviour of animals before major seismic events. Usually, such behaviours are apparent from a few minutes to an hour before the first shock. Out of the 128 cases classified as "precognitive" (see Persinger, 1974d), 23 percent dealt with some situation where the person presumably saved his own life by heeding some "hunch". In more than 60 percent of these cases the event occurred within seconds or minutes of the avoidance behaviour. Could infrasound have been the stimulus that evoked the sensation that these people labeled as a "hunch"?

In this context, the ideas and concepts developed by Finkelstein and Powell (*e.g.*, 1970), may have important application for some types of paranormal experiences. Attempting to understand the mechanisms involved with luminescences and lights which occur often before major earthquakes, they have calculated that values of up to 10^5 V/m may exist in stress zone areas. The exact voltage values depend upon local quartz concentrations, the intensity and direction of the stress and the temporal characteristics of the accumulating stress. Seismic waves could produce an effective 1 km^3 antenna carrying a current 1 A to 10 A at the spectral maximum which usually peaks around 1.5 Hz, with important contributions from frequencies between 1 Hz to 10 Hz. Since stresses of only 10–100 bars are sufficient to produce significant voltages, stimuli from slowly accumulating pressures could be available to the susceptible subject for some days in advance. Detection (*e.g.*, an anxious dream response), of the geophysical stimulus before the objective event (*e.g.*, an earthquake), occurring sometimes later when stresses have reached fracturing intensities, would then be misinterpreted as an example of "seeing into the future".

Limitations of the Candidate

As with ELF-EM fields one fundamental problem is involved with the dynamics by which weak ambient infrasonic waves interact with the body. It is unlikely that the ear directly responds to infrasound since Von Bekesy has calculated that pressures of 2000 dyne/cm^2 at 1 Hz are required for threshold values. A clue perhaps can be gleaned by the experimental data. The human body vibrates between 4 Hz and 12 Hz with amplitudes of 10 μ; under muscle tension the vibration amplitude increases to 50 μ. Rohracher (1955) has reported that these vibrations continue for about an hour after death and may normally increase their frequency or amplitude during fever, menstruation and other temperature-related changes in the human body. Most physical structures have a "natural frequency", which if approximated, can initiate positive feedback sequences that result in system destruction. Sustained external oscillations at natural frequencies of a system allow energy transfer to take place. If the oscillations are not damped or the energy dissipated, less plastic systems begin to collapse. Most experi-

menters agree that the "natural frequency" of the skeletal musculature exists in the Rohracher vibration range. It is not surprising from this point of view that many of the most aversive effects of experimentally produced infrasonic vibrations occur at the natural frequency band of the musculature (Stephens, 1969).

Weak infrasonic oscillations from ambient sources may not be sufficient to elicit full-blown symptoms but could evoke responses of a less severe nature. One of the most interesting qualities of some categories for telepathic-clairvoyant or precognitive (depending on the time reference) experiences involved with natural physical events, is the lack of specificity in experience content. Reporters of these experiences do not say that they felt an earthquake coming, or a tornado nearby or the hill on the right side of the house about to collapse. Instead the reports include statements like "feelings of foreboding", "depression" or "impending doom". Verbal descriptions of these types are used to refer to the effects of diffuse autonomic stimuli which do not have the stimulus specificity to evoke specific responses of "content awareness" or more detailed images in the brain. These experiences can be so unpleasant that the person leaves the area before the possible lethal event takes place. In other words, inherent properties of the infrasound stimuli themselves are of sufficient quality to evoke an avoidance response in the subject. Experiments by Wike and Wike (1972) indicate that low frequency stimulation is aversive to rats since they will learn to select levers which terminate the vibration. The most conspicuous limitation of the infrasound candidate becomes apparent when living stimuli are the presumed agents. Although ambient infrasound might be available in the agent's immediate environment, it is difficult to see how any modulation by the agent would take place.

HIGH VOLTAGE STATIC FIELDS

The coincidental occurrence of electrical storms during paranormal experiences has been a predominate theme in the popular literature. No doubt any reference to thunder and lightning may only reflect the significant psychological effects from the intensive and unpredictable auditory and visual stimulus presentations. However one concomitant of electrical storms, high voltage gradients, is of importance to psi-transmission models.

Sources

Electrical gradients from meteorological sources vary greatly in intensity. Normal gradients display values of only 115–140–V/m, with the larger voltage at the greater height. The existence of a positive potential gradient indicates the presence of a negative charge on the ground. During land rain the gradient is mainly negative while during thunderstorms there are large fluctuations between positive and negative values. Tromp (1963) notes that values of up to 10,000 V/m have been recorded during violent electrical storms. Snowfall is accompanied by high positive and negative potential gradients also, while during fog conditions more stable potentials of up to 2000 V/m can be accomplished. The other major source of high voltage gradients, piezoelectric effects from seismic stress areas, has been mentioned. High static electric fields would show no essential propagation per se. Penetration would be possible where the field surface is much larger than the area to be penetrated. Alternatively, electrostatic effects could be mediated through conductive materials (*e.g.*, telephone lines, power lines) that penetrate dwelling structures.

Biological-Behavioural Effects

Anecdotal observations indicate activity changes of many species before thunderstorms (Altmann, 1969). Biometeorologists have reported correlational studies that indicate feelings of depression, uneasiness, restlessness and similar aversive autonomic experiences can precede approaching storm situations. At times the visual cues of cloud collection and decreases in sunlight do not accompany transient increases in electrostatic gradients, but the behavioural experiences of people exposed to these environments are similar. Human subjects exposed to gradients in the laboratory report comparable experiences.

Mechanism of Effect

Direct effects of electrostatic forces upon the individual neuronal membrane is unlikely, even under optimal conditions. Despite relatively impressive ambient levels of 10,000 V/m, these intensities do not approach the 10,000,000 V/m which is

set up across the nerve membrane (−75 mV/75 Angstroms). Nernst equation values show that any direct disturbance would induce less than 1 mV change around resting potential. However weaker, organismic fields do exist that may be influenced. Becker, Bachman, and Friedman (1962) have measured potential differences over the human body which display specific isopotential contours. Foci of concentric isopotentials near the back of the head are positive with respect to the front of the head (Presman, 1970, p. 237). Anterior portions of the spinal cord at the base of the neck and posterior portions near the coccyx display positive foci relative to the distal portions of the limbs, which are negative. These processes are in some way related to known neuroanatomical pathways since transections eliminate the spinal cord-appendage potentials. Becker, Bachman, and Friedman (1962) suggest that this direct current (d.c.) system regulates the fast axonal system, a not untenable idea in view of modern CNS modulator concepts, and transmits slow pain information. It is this system which may control the interaction between biosystems and ambient electric and magnetic fields. Experimental evidence strongly points in this direction.

Relevance to Paranormal Experience

Effects of ambient electrostatic or biofrequency fields upon the human electrical systems have important implications for parapsychological research. For some decades now, a handful of men like Ravitz (1962) and Burr (1972) have been emphasizing the pervasive role of low intensity bioelectrostatic fields in life forms. Burr implicated bioelectrostatic fields associated with the organism as "blueprints" for developing fetal systems.

Biofields may also be more sensitive indicators of complex cerebral phenomena than conventional tools. Ravitz (1962) noted that during hypnosis there was a decrease in the steady potential between the head and chest, yet no variation on the EEG records. More recent data by Friedman and Taub (1969) indicate that "attentiveness" as measured by reaction time is strongly related to shifts in the head potential polarities. Other experiments by Ravitz (1962) indicated that high intensity configurations of opposite than normal polarities occur during adolescence and that emotionally unstable patients showed the greatest variations in not only intensities but dominant polarities.

These fascinating data lead to many questions. How stable is the steady potential system of the body? Can polarity reversals or intensities of the d.c. system be influenced when the subject is exposed to high intensity static fields created in nature? Such an occurrence may not only affect the subject's ability to attend to usual environmental stimuli, but modify his suggestibility to relatively bland events. A person might, under these conditions, perceive a normal object in completely different context. He might experience a normal dream as a "real experience". Interestingly, one of the most electrically unstable portions of the brain (the hippocampus), is the very structure which would allow a rich series of images and memories to be experienced.

That vivid and extremely real images can be elicited artificially in the brain has been known since the classic studies of Penfield and Perot (1963). Less known are the experiments by Leduc (see Herin, 1968) who applied small currents to his brain and reported a paralysis followed by a dream-like state where everything about him seemed unreal. Unpublished data from this laboratory suggests that some individuals reported "drug-like experiences" of euphoria-depression or depersonalized-like episodes following microamp current application across the frontal-occipital scalp or between the frontal scalp and leg. It remains to be verified if natural electrostatic intensities can induce comparable currents. However Becker (1972) found that current intensities within tissue need only be within a few millimicroamps to be effective.

Relevance to Paranormal Experiences: Physical Effects

Finkelstein and Powell's initial interest in seismoelectric effects were involved with explanations of short-termed luminosities that occur during earthquakes in areas with strong piezoelectric materials. They suggested that local ionizations of the air under optimal conditions were responsible for these phenomena in analogous manner to ball lightning production when high voltage gradients during thunderstorms are exposed to charged air. Their ideas of electrostatic sources of ball lightning have been reported (Powell and Finkelstein, 1969).

In principle, there is no reason that similar

short-termed luminosities might not occur in or above areas with seismic stresses where piezoelectric conditions are available. Similarly, it is feasible that these stress-induced electric fields may act as a means of responding to or elevating crustal pressures where intensities have not reached values that would cause total fracture. If the voltages did not reach values capable of ionization or if the atmospheric constituents were not appropriate, ionization-like manifestations could not occur, but voltages for kinetic phenomena would still be available in the vicinity. The high voltages, by necessity would be short lived, rarely lasting more than a few seconds to a few minutes at a time and reflecting underlying seismic pressure accumulation and releases on piezoelectric materials. Prediction of when piezoelectrically induced fields would take place is more difficult and requires direct information on the time distribution-intensity factors of the force and the flexibility of the material. An important implication of this model is that large volumes of crustal block sharing similar stresses may include surface areas for hundreds of square kms. Only certain areas with the appropriate geoarchitecture would be first to manifest the effects.

One would further expect that duration of the electric field related manifestation would depend upon the net intensity per unit time. For any given period of more or less constant peak strain values, bright luminosities would be briefer in duration than fainter ones; larger objects would move less distance and less often than smaller and lighter ones. The amount of potential energy is more or less constant and dependent upon deformation properties of the piezoelectric material under stress. Consequently, the amount of kinetic energy displayed *within* an event should be similar across events. This would mean that whereas a glass may move across the room, a chair may only tip over. The Roll data (*e.g.*, Roll, Burdick and Joines, 1973) could fit such a model.

Certain paranormal phenomena like haunts and poltergeists share an interesting property with the high voltage ambient fields discussed here: both are transients. Both haunts and poltergeist events are remarkably short-termed in a particular manifestation. The number of haunt episodes can be frequent but seem aperiodic. Poltergeists, on the other hand, usually last a few weeks with events cascading as the termination approaches. Geophysical models would predict that areas of classical haunts reflect spatial locations of maintained seismic strain with minor variations in intensity, while poltergeist occurrences indicate rapidly accumulating pressures that are either attenuated or relieved in a short time. Such speculation could be empirically verified.

With an assumption that transient, ambient high voltage fields are in some systematic way related to paranormal kinetic and visual phenomena, predictions can be made for probable spatial locations of occurrence. Areas with the appropriate mineral and topographic architecture can be readily discerned with the massive amount of geophysical information that has been routinely collected over North America for decades. Areas adjacent to conductive areas or current sources like some underground streams would be one probable locus. Surface areas near the crescents of hills which have underlying rock alignments at angles capable of producing geometries that facilitate coronal-like discharges would be another. As stresses across a crustal block increased, these areas would be proportionately affected. The particular objects affected would be predominantly dielectrics and the direction of movement would depend upon vectorial features of the field.

Temperature Fluctuations: an Example of Mechanism

Much discussion has been given concerning the general principles by which environmental energies might contribute to paranormal events and experiences. Perhaps a more precise example of a mechanism would further support the utility of exploring physical models as means of understanding the dynamics of the verifiable physical effects in paranormal cases.

One property of some haunts and poltergeists is fluctuations in temperature. Natural occurrence of the Peltier effect could result in significant reductions in temperature. For this effect to take place a thermoelectric material must exist between two conductive layers such that the only contact (junctions) between the two conductive layers is by the thermoelectric material. The material would be in a columnar form, beneath the house, and composed of a thermoelectric substance like manganese silicate. The thermal conductivity, resistivity and Seeback coefficient of such substances have been determined. Close contact between the upper conductive plate and

the foundation of the house is an essential factor.

An average room, with a temperature of 25° C would require a 600 BTU/hr cooling capacity to reduce the temperature by, for example, 9° C. For such a fluctuation to occur, heat removal rate of 180 watts would be required. Calculations, (Persinger, 1974e) indicate that local voltages applied across the two conductive layers would result in removal of heat from the junction, so that cooling periods in the order of 10 minutes could exist. The cooling would be facilitated in areas where the foundation of the house is in good contact with the conductive layer and thermoelectric junction, a probability that would be high in older houses which are frequently associated with haunt-types of episodes. Proportionally more cooling episodes would occur proximally to the conductive layer, such as in the basement and first floor areas. Manifestation of the cooling effect in a hallway would be additionally noticeable since the limited gas volume would have less access to heat compensation from adjacent areas of the room or house. For the majority of cases, duration of an event would be short lived at any given time as the voltage sources are attenuated, but the number of events could increase as geophysical factors change. Meteorologically associated electric fields, such as those accompanying thunderstorms, could also charge the "plates" separating the thermoelectric material. However this source would play a more important role in houses or areas on hills or above geophysical structures where field shunting and concentration could take place.

The Peltier cooling model may have application. It is interesting because a variation of the model allows *heat production* to take place on the junction when vectorial patterns of the applied fields are changed. Even with these options, realistic problems must be considered. Does it seem likely that the thermoelectric material is deposited only under the house? Or does it happen that people are more likely to notice these occurrences once the house is built? Do other areas constitute the predominately small spatial domains that are labeled as the abode of "gremlins," "evil forces," or "forest spirits?"

Conclusion

It is emphasized that the models discussed in this paper are not meant to refer to every instance of parapsychological experience. Instead, the geophysical models apply to those situations where veridical evidence demands some type of energy transfer for the phenomena to occur. The advantage of models with physical bases is that predictions can be both qualitatively and quantitatively made and measured. There are immense energies in our everyday environment. Some are known more frequently than others. Their participation in the human experiences labeled as "paranormal" would dictate a greater understanding of the complex matrix of environmental stimuli to which we are exposed.

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A Comment

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In "Geophysical Models for Parapsychological Experiences," Dr. Persinger states that "for a physical environmental stimulus to be selected as a candidate mechanism for a casual or correlational source of paranormal phenomena" it must satisfy the criterion of *penetrability*. Indeed, penetrability is an important factor in attempting to define mechanisms for paranormal occurrences. Utilizing this criterion, I question whether it has been adequately demonstrated that extremely low frequency electromagnetic fields can "penetrate" grounded, conductive shielding devices, i.e., a Faraday cage inside of which telepathic experiments are conducted. This consideration is important if the paranormal occurrences mentioned in this paper are to include such phenomena as telepathy and clairvoyance.

Persinger himself points out that the discussed models are not meant to refer to every instance of parapsychological experience. However, in attempting to measure and qualify certain geophysical processes which may be related to paranormal events, he has made a significant contribution to this area of reasearch. Until now, most of the experiments concerning psi phenomena have focused on verifying the existence of these events. It is hoped that this article will stimulate more research into the possible mechanisms of paranormal occurrences.